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Washington, D.C. 20590-0001

Re: Docket Number FAA-2003-14715

To Docket Office and Federal Aviation Administration:

The National Park Service, through Grand Canyon National Park, is submitting the following comments on the supplemental notice of proposed rulemaking "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park."

We thank the Federal Aviation Administration (FAA) for the opportunity to present comments on the FAA proposed standards for quiet technology and noise limitations for certain aircraft operations within Grand Canyon National Park. We see these proposed standards as a meaningful effort to help achieve our mutual statutory mandate to provide for the substantial restoration of natural quiet as required under Public Law 100-91.

In general, we agree with the FAA's desire to use "noise efficiency" to define "quiet technology" and to reduce the total acoustic impact of air tour noise on Grand Canyon National Park. However, noise efficient aircraft may be noisier on a per flight basis, but less noisy on a per seat basis. Noise savings occur because larger capacity aircraft require fewer flights to carry the same total number of people and fewer flights result in less total noise. The reduction in total noise emissions is the result of fewer flights, not necessarily the result of flying noise efficient aircraft. By flying fewer operations and using noise efficient equipment, progress toward substantial restoration of natural quiet can be made without a reduction in total passenger carrying capacity.

***How reasonable is the noise efficiency approach...and how appropriate is the use of certificated noise level as the basis?***

As acknowledged in this proposed rule, adoption of a definition of noise efficiency, by itself, does not move Grand Canyon National Park toward the goal of substantial restoration of natural quiet as mandated under Public Law 100-91. Further, it is unlikely that the implementation of noise efficient aircraft alone will result in the achievement of substantial restoration of natural quiet. Achieving that goal will also require a reduction in one or more of the following: number of operations, area overflown, duration of the daily flight period, and duration of each flight.

Quiet technology, which is based on noise efficiency ratings, depends on a sound level measurement under certification (controlled) test conditions. However, aircraft audibility is the standard for measurement and modeling of substantial restoration of natural quiet at Grand Canyon. Audibility depends on the actual operating conditions and on the specific frequency content of the aircraft noise. The success of converting to noise efficient equipment assumes that the noise efficiency ratings presented in the SNPRM accurately represent aircraft audibility

under environmental operating conditions. Because certification values do not include specific frequency information, some aircraft determined to be quiet technology may not be quieter than other non-quiet technology aircraft when measured by audibility.

The National Park Service (NPS) recommends that the sound levels produced by “quiet technology” aircraft be analyzed in terms of audibility to ensure that the aircraft is, in fact, less audible than the non-quiet technology aircraft. Without such an analysis, tour operators could purchase new aircraft that negatively impact the substantial restoration of natural quiet – contrary to the requirements of the National Parks Air Tour Management Act. Please see the attached memorandum: “Relationship Between Audibility of Tour Aircraft and Certification Data.”

***What economic and operational incentives should be considered if quiet technology is implemented?***

Offering an increase in the total number of operations as an incentive for conversion to noise efficient aircraft is counter-productive for efforts to achieve the mandate of substantial restoration of natural quiet in Grand Canyon National Park. Because noise efficient aircraft may be noisier on a per flight basis than non-noise efficient aircraft, substitution of noise efficient aircraft for current aircraft may cause total noise emissions to increase. For noise efficiency to be an effective tool in working toward the substantial restoration of natural quiet, it is clear that the number of operations will have to be reduced rather than increased. Economic or operational incentives that reduce the amount of substantial restoration of natural quiet are counter to the mandate of Public Law 100-91 and Public Law 106-181, Section 804.

This proposed rule provides standards for quiet technology aircraft by defining “noise efficiency.” The implementation of this rule, should it be adopted, is delegated by law to the National Parks Overflights Advisory Group (NPOAG). One incentive for NPOAG consideration centers on reverted allocations. If a small portion of the reverted allocations were re-distributed to operators using noise efficient aircraft, progress toward the mandated goal could be achieved at the same time as the adoption of noise efficient aircraft is promoted. By regulation (14 CFR 93.321), overflights allocations are an “operating privilege” and it is within the FAA’s authority to withhold or redistribute allocations.

Overflights legislation and federal regulations give the FAA the authority to work with the NPS to achieve substantial restoration of natural quiet at Grand Canyon National Park. By effectively (1) controlling the re-distribution of allocations within the industry, (2) capturing the allocations that revert to the government, and (3) providing for a limited redistribution of reverted allocations, progress toward the achievement of substantial restoration of natural quiet can be made, while simultaneously offering an incentive for the adoption of noise efficient equipment.

***Incentives and “flexible” cap adjustments?***

Significant gains in the amount of substantial restoration of natural quiet achieved continue to be

the overriding purpose for the implementation of a quiet technology aircraft ("noise efficiency") regulation. Incentives that reduce the level of substantial restoration of natural quiet are counter to the mandate of Public Law 100-91 and Public Law 106-181. Because Grand Canyon National Park is some distance from achieving substantial restoration of natural quiet, reductions to the level of substantial restoration achieved due to noise efficiency incentives will require more stringent constraints to be applied elsewhere.

Noise budgets constitute one form of a "flexible" cap. Under a noise budget, each operator is allocated a quantity of noise ("decibel-minutes") equivalent to the amount and duration of noise his operations created during the 1997-98 base year. With this noise allocation, each operator is free to choose what type of equipment he/she to fly. Use of less noisy equipment will equate to more minutes of operation. Substantial restoration of natural quiet may be achieved through a reduction of the appropriate percentage of each operator's noise allocation.

### ***Growth tied to an incentive system?***

The purpose of conversion to a noise efficient fleet of air tour aircraft is to achieve measurable gains in the amount of substantial restoration of natural quiet. Growth or incentives that reduce present levels of substantial restoration of natural quiet are contrary to Public Law 100-91 and Public Law 106-181.

Because of the way in which noise efficiency is defined, conversion to noise efficient aircraft could result in the use of aircraft that are noisier, in an absolute sense, than the aircraft they replace. Noise efficiency is calculated on a per seat basis, not on the total noise emissions of the aircraft. The use of noisier equipment coupled with an increase in the number of operations will compound the difficulty in achieving substantial restoration of natural quiet in Grand Canyon National Park. Limited growth in the number of operations, however, might be possible through a partial redistribution of reverted allocations.

### ***What Operational Limitations (phase out, expanded curfews, noise budgets, quota system, etc.) should be considered, and how should the Quiet Technology decision be used?***

The NPS recommends the use of all available methods to promptly and efficiently achieve the goal of substantial restoration of natural quiet at Grand Canyon National Park. As illustrated in Table 1 (March 24, 2003, Federal Register, page 14277), the path toward substantial restoration has been tortuous and the progress along that path has been limited. The NPS recommends that the FAA use their management discretion to set, revoke, and distribute flight allocations for the benefit of natural quiet. The NPS recommends a system that takes advantage of current market conditions to revoke and retire allocations, that fairly and openly adjusts allocations to accommodate achievements in implementing quiet technology, and that supports business innovations that effectively reduce aircraft generated noise.

The following comments request specific additions or changes to the text of this SNRPM:

1. The definition of "noise efficiency," that is, "larger aircraft with more passenger seats are allowed to generate proportionally more noise" (page 14276, column 1) may be misleading, especially when the term is used in the context of Grand Canyon National Park. The "efficiency" in noise efficiency is due to a reduction in the number of flight operations. This critical component should be included here and with other similar usages.
2. Table 1 (page 14277) is become dated. A summary for the year 2002, including the U.S. Court of Appeals decision, should be provided.
3. The latter parts of the "History" section (page 14280) are outdated. A summary of the August 2002 decision of the U.S. Court of Appeals should be included.
4. Similarly, the Aircraft Noise Model Validation Study section requires up-dating. The study was completed in January 2002 and the recommendations of that study should be reported here.
5. Footnote 4 (1) (page 14280) should indicate that the study exercised both INM version 5.1 and INM in its Research Version, rather than just the one listed.
6. Also please note that "Aircraft Noise Model Validation Study" is the correct title for this report.

Thank you for the opportunity to provide comments on the supplemental notice of proposed rulemaking, "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park." We look forward to working with you to achieve our shared mandate of substantial restoration of natural quiet at Grand Canyon National Park.

Sincerely,

Joseph F. Alston  
Superintendent

Enclosure

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## MEMORANDUM

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**To:** Ken McMullen  
National Park Service, Grand Canyon National Park

**From:** Jason C. Ross, Nicholas P. Miller, Richard D. Horonjeff

**Date:** June 9, 2003

**Subject:** Relationship Between Audibility of Tour Aircraft and Certification Data

**Reference:** HMMH Job No. 295860.420

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### 1. Introduction

The National Parks Overflights Act of 1987 (Public Law 100-91) mandated that the National Park Service provide for the "substantial restoration of the natural quiet" at Grand Canyon National Park (GCNP) in order to reduce significant adverse effects on the natural quiet and experience of the park<sup>1</sup>. In a report to Congress published in 1995, the NPS stated that the "primary measure of restoration is the percentage of time that aircraft are audible."<sup>2</sup> In order to further these efforts, the National Parks Air Tour Management Act of 2000 (Public Law 106-181) requires that reasonably achievable "quiet aircraft technology" be determined for use at GCNP.<sup>3</sup>

The Federal Aviation Administration (FAA) in March 2003 issued a supplemental notice of proposed rulemaking (SNPRM) on "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park."<sup>4</sup> The sole purpose of the 2003 SNPRM is to define quiet technology. It is anticipated that the air tour companies that use "quiet technology" aircraft will be given incentives for operating these quiet aircraft; however, this is not the subject of the SNPRM.

Because the interpretation of natural quiet hinges on the concept of audibility, it is critical to the goal of substantially restoring natural quiet in GCNP that the method used to determine quiet technology status correlate well with the audibility of tour aircraft in a park setting. That is, air tours using quiet technology aircraft, as they are typically flown in the Canyon, should be less audible in the GCNP environment than tours flown with aircraft that do not meet the definition of "quiet technology". The quiet technology aircraft should be less audible

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<sup>1</sup> National Parks Overflights Act, Public Law 100-91, 1987.

<sup>2</sup> National Park Service, "Report on Effect of Aircraft Overflights on the National Park System" Report to Congress, p. 182, July 1995.

<sup>3</sup> National Parks Air Tour Management Act, Public Law 106-181, 2000.

<sup>4</sup> Federal Aviation Administration, "Noise Limitation for Aircraft Operations in the Vicinity of Grand Canyon National Park", Supplemental Notice of Proposed Rulemaking, March 2003.

# HARRIS MILLER MILLER & HANSON INC.

Relationship Between Audibility of Tour Aircraft and Certification Data  
Ken McMullen, Ken Weber

Page 6  
June 9, 2003

in terms of the distance at which they may be heard, the length of time single flights are audible, and the number of flights required to service a given passenger demand.

Considerable effort has gone into developing the FAA methodology, and the rationale for the proposed procedure is well presented. The FAA's proposed rulemaking bases the determination of "quiet technology" on a combination of the certificated noise levels as required by Federal Aviation Regulation (FAR) Part 36 and the number of passengers that an aircraft can hold; this combination is referred to as "noise efficiency." One benefit of the proposed approach is that noise certification data are readily available in the public domain. Another benefit is that such data are highly reliable and repeatable.

This memorandum builds on the effort developed by the FAA by investigating the correlation between certification sound level data and audibility-based metrics for several aircraft that are commonly flown over GCNP. The proposed rulemaking does not include any indications of what benefit or incentive air tour operators may be provided for utilizing "quiet technology". Therefore, it is not clear that utilizing aircraft with the capacity to service more passengers would necessarily result in fewer operations. This memorandum compares certification sound level data to audibility-based metrics on both a "noise efficiency" basis and on an aircraft-to-aircraft basis.

This paper presents data from certification measurements as proposed by the FAA for determining "quiet technology" as well as computed audibility metrics for five aircraft that are typically used for air tours in GCNP. For each aircraft, a cruise-speed constant elevation pass-by was modeled to produce audibility metrics including maximum level of detectability (d-prime), the frequency at which detection occurs, and the total length of time that an aircraft would be audible.

Reference sound levels for the aircraft were measured at GCNP in 1999 as part of the Aircraft Noise Model Validation Study<sup>5</sup>. These data were collected from aircraft actually flown at GCNP under typical operating and atmospheric conditions. The data for these aircraft include 1/3-octave band sound level frequencies between 50 and 10,000 Hertz. Aircraft audibility is determined by the relationship between the aircraft sound level and the ambient sound level, which acts to mask it; this relationship depends upon frequency content. The following figure illustrates the importance of frequency on the audibility of sounds. Although this distant aircraft has a relatively low A-weighted sound level of 26.4 dBA, the aircraft is audible because the strong low frequency tone in the 125-Hertz 1/3-octave band exceeds the threshold of hearing in that same 1/3-octave band. Because audibility is based on spectral data, and certification data present a single number representation of noise level, aircraft that are "quiet technology" when rated according to the single number certification-based data may not be

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<sup>5</sup> Horonjeff, Richard, "Memorandum: Transmittal of Modeling Data, Grand Canyon Model Validation Study," HMMH Project No. 295860.14, September 12, 2000.

"quiet" when rated according to audibility. Specifically, an aircraft with a lower A-weighted sound level may not necessarily mean it is less audible if it has stronger or lower frequency tones than another aircraft.

This study shows that there is reasonably good correlation between the A-weighted certification sound levels on a "noise efficiency" basis and the amount of time aircraft are audible per passenger. On an aircraft-to-aircraft basis, however, the correlation between the A-weighted certification sound levels unadjusted for passenger capacity and the amount of time that aircraft are audible is not as strong. Therefore, the methodology proposed by the FAA is predicated on the "noise efficiency" idea of allowing higher sound levels for aircraft with greater passenger capacities rather than the actual audibility of the aircraft.

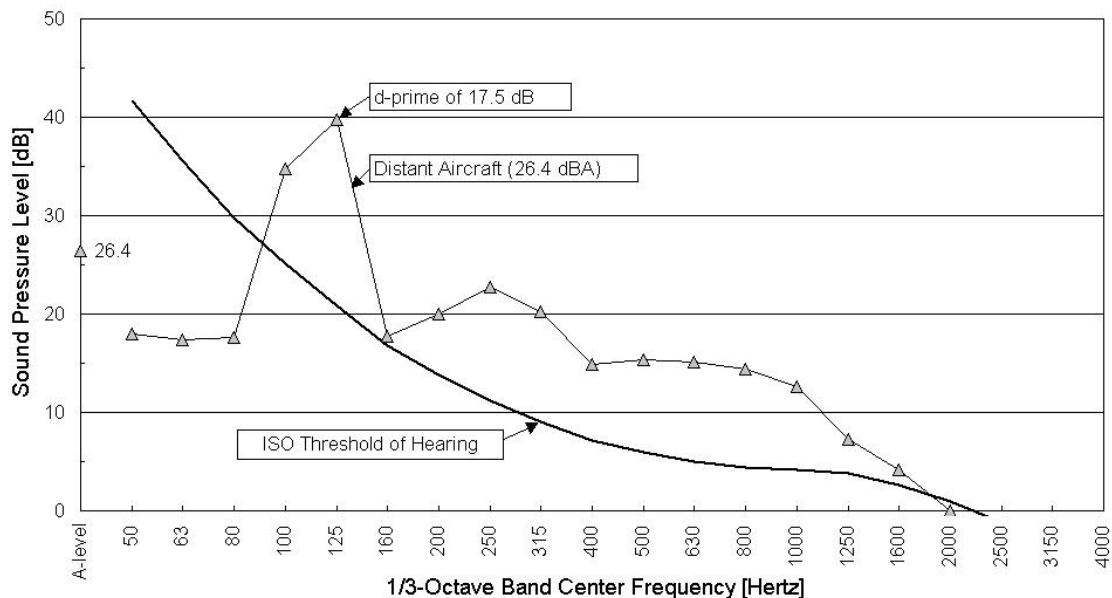


Figure 1. Audibility of a Distant Aircraft

## 2. Methodology

The goal of this analysis is to rank-order possible tour aircraft on the basis of minutes of audibility per aircraft pass-by and minutes of audibility per available passenger seat and relate these rankings to the aircraft's ranking based on certification sound level data.

### Data Set

Audibility calculations require the use of sound level data measured in  $\frac{1}{3}$ -octave bands, from 50 Hz to 10 KHz. The FAR Part 36 certification procedure applicable to the kinds of light aircraft used in air tour operations does not require the acquisition of this kind of data; however, tape recordings that could provide this level of data are often made during certification measurements. The  $\frac{1}{3}$ -octave band data set shown in Table 1 was collected using tape recordings at GCNP. The average tour aircraft speed observed during the measurements was 100 knots, which was used for all of

# HARRIS MILLER MILLER & HANSON INC.

Relationship Between Audibility of Tour Aircraft and Certification Data  
Ken McMullen, Ken Weber

Page 8  
June 9, 2003

the audibility calculations. The sound levels were normalized to a standard measurement reference distance of 1,000 feet and atmospheric conditions consistent with those required for certification tests. Sound levels were determined at 10-degree angles around the entire aircraft in order to properly model the emissions of the aircraft in regard to its orientation to the receiver.

Table 1. Aircraft Spectral Data Set

Data Set	Source	Aircraft Types	Engine Power	Details of Data Available
I	See Footnote [5] above	AeroStar 350, helicopter Bell 206L, helicopter Cessna 182, 1-propeller Cessna 207, 1-propeller DHC-6 Vistaliner, 2-propeller	Tour, Cruise	Multiple spectra at 10 degree angles around aircraft

## *Model Geometry*

Experience from aircraft sound level measurements and listening tests performed during the September 1999 Grand Canyon Model Validation measurements indicated that tour aircraft are readily audible under quiet listening conditions at distances of 5 miles or more from the aircraft flight track. For the purposes of this analysis a distance of 25,000 feet between the observer and the aircraft flight track was used in the audibility calculations. The aircraft were modeled flying a straight flight path, at a speed of 100 knots, a constant altitude of 2,000 feet and at a closest point of approach (perpendicular distance) of 25,000 feet from the modeled receiver location. A closest point of approach of 25,000 feet was chosen mainly because there are many areas of the Grand Canyon that have a clear line-of-site to flight corridors five miles away.

## *Sound Propagation Considerations*

Sound levels decrease with increasing distance between the source and the receiver. For the purposes of this analysis two sound propagation effects were considered: (1) spherical spreading, which is independent of frequency and results in a six decibel reduction in sound level for every doubling of distance between source and receiver, and (2) atmospheric absorption which is frequency dependent and depends on temperature and relative humidity. The atmospheric absorption method used in this analysis is the same as that used in aircraft noise certification procedures<sup>6</sup>. Absorption losses are greater at high frequencies than at low. At large distances the vast majority of high frequency energy is lost,

<sup>6</sup> Society of Automotive Engineers, Committee A-21, "Standard Values of Atmospheric Absorption As A Function of Temperature and Humidity," Aerospace Recommended Practice (ARP) 866A, March 15, 1975.



leaving only the lower frequencies to be detected by human observers.

## *Ambient Sound Level Conditions*

Without the effects of wind and moving water there is very little in the Grand Canyon that acts as an effective acoustic masker to aircraft noise. If wind is present, its interaction with local foliage creates some masking noise in the lower frequency region where aircraft can be heard. Animal sounds, such as birdcalls, are generally at higher frequencies than aircraft and do not act as maskers to aircraft. Past measurements during low wind conditions indicate that in the lower frequency bands where aircraft are audible at long distances, the human threshold of hearing, not ambient sounds, is likely to be the controlling factor in aircraft audibility. Therefore, the human threshold of hearing was used in this analysis for the purpose of determining aircraft audibility.

## *Model Parameters*

The model calculates a time series of sound levels as the aircraft passes by a receiver on the ground. We analyzed the time series to determine the detectability level (d-prime), and the frequency at which the aircraft was most detectable. A threshold for audibility derived from field observations occurs where d-prime is greater than or equal to 7 dB<sup>7</sup>. The auditory signal detection algorithms used in this analysis are the same as those employed in the National Park Service's NODSS computer program<sup>8</sup>, originally set forth in software developed for the United States Air Force<sup>9</sup>. The results from all the position points create a time series for each of these parameters. A typical plot of aircraft audibility versus time is shown in Figure 2.

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<sup>7</sup> Fidell, Sanford, et al., "Evaluation of the effectiveness of SFAR 50-2 in restoring natural quiet to Grand Canyon National Park," NPOA Report No. 93-1, June 23, 1994, p. 55.

<sup>8</sup> Reddingius, Nicholas H., "User's Manual for the National Park Service Overflight Decision Support system," BBN Report No 7984, prepared under Contract No. CX-2000-9-0026, May 1994.

<sup>9</sup> Horonjeff, Richard D. et al, "United States Air Force Acoustic Range Prediction Program," USAF Technical Report No. AFWAL-TR-83-3115, 1983.

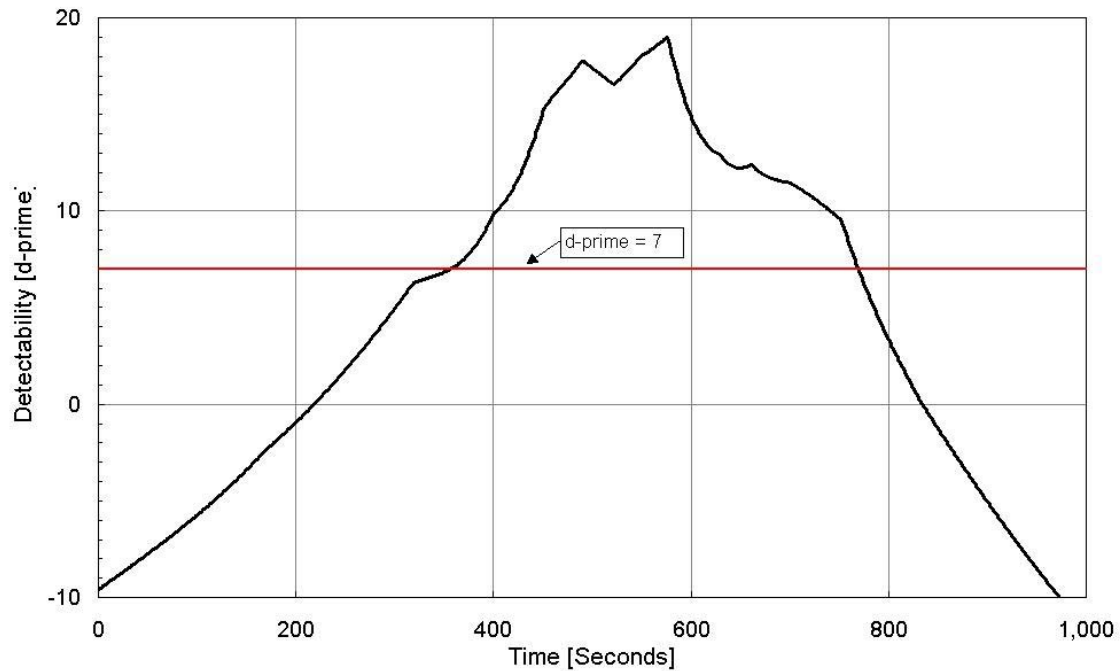


Figure 2. Audibility Time History of AeroStar 350 Helicopter Pass-by

### 3. Results

The results are summarized in below in Table 2 and Table 3. Column 1 identifies the aircraft type. Column 2 tabulates the number of available passenger seats, excluding the pilot(s). Column 3 is the certificated sound level for each aircraft that is referenced in 14 CFR Part 36, the reference level proposed the FAA.

The fourth column presents the computed maximum detectability level (d-prime) at a horizontal distance of 25,000 feet and an altitude of 2,000 feet. Column 5 identifies the  $\frac{1}{3}$ -octave band frequency where the aircraft is most detectable<sup>10</sup>.

In Table 2, columns 6, 7, and 8 are all based on "noise efficiency" calculations where benefit is given to an air tour based on its capacity (number of passenger seats). Column 6 tabulates the "quiet technology" criterion for each aircraft including the "noise efficiency" adjustment for the number of passenger seats in the aircraft as proposed by the FAA. The appendix in 14 CFR Part 36 from which the sound level was derived is also indicated. Column 7 shows the difference between the certificated sound levels and the "quiet technology" criteria. This metric determines whether or not an aircraft is considered to be "quiet technology". For example, from Table 2, we can see that the DHC6-Vistaliner has a QT Measure of -1.5 dB, which indicates that it meets the standard proposed by the FAA for "quiet technology" - the certificated noise level is 1.5 dB lower than the QT criterion. This is the only aircraft in our study that meets the "quiet technology" standard. The Bell 206L, on the other hand, exceeds the QT criterion by 1.2 dB. Column 8 presents the time audible per passenger seat in minutes that was

<sup>10</sup> Based on measurements.

# HARRIS MILLER MILLER & HANSON INC.

Relationship Between Audibility of Tour Aircraft and Certification Data  
Ken McMullen, Ken Weber

Page 11  
June 9, 2003

described previously (i.e., total time audible divided by the number of passenger seats).

Columns 6,7, and 8 in Table 3 are metrics that do not include any benefit for the number of passenger seats on the aircraft. Column 6 tabulates the "quiet technology" base criterion for each aircraft without including the "noise efficiency" adjustment for the number of passenger seats. Column 7 is a comparison of the certificated sound levels to the "quiet technology" base criterion without adjusting the criterion for the number of passengers shown in column 6. The proposed rulemaking does not contemplate using this metric to determine whether an aircraft should be considered "quiet technology". It is simply a means to compare the sound levels of the aircraft to each other without adjusting for passengers. Column 8 presents the time audible in minutes for each aircraft that was modeled without dividing by the number of passengers.

Table 2. Seat-adjusted "noise efficiency" based quiet technology rankings

Aircraft	Seats	Certification Level (dBA or EPNdB) (Appendix )	Maximum 10 Log of d-prime (dB)	Frequency of Maximum Detection (Hertz)	Seat-Adjusted Rankings		
					QT Criterion (dB)	QT Measure (dB)	Time Audible per Seat (minutes)
DHC6 - Vistaliner	19	77.3	16.0	160	78.8 <sup>F</sup>	-1.5	0.13
Bell 206L4	5	85.2*	14.6	315	84.0* <sup>H</sup>	1.2	0.90
AeroStar 350BA	6	86.8 *	21.1	315	84.8* <sup>H</sup>	2.0	1.14
Cessna 182	3	73.5**	21.2	250	70.8 <sup>F</sup>	2.7	1.74
Cessna T207A	6	77.9	19.9	250	73.8 <sup>F</sup>	4.1	0.72
* EPNL level are used for these helicopters.							
** Certification level is the arithmetic average of the Cessna T182 and the Cessna TR182.							

Table 3. Aircraft-only based quiet technology rankings

Aircraft	Seats	Certification Level (dB) (Appendix )	Maximum 10 Log of d-prime (dB)	Frequency of Maximum Detection (Hertz)	Aircraft-only Rankings		
					QT Base Criterion (dB)	QT Measure (dB)	Time Audible (minutes)
Cessna 182	3	73.5	21.2	250	69.0 <sup>F</sup>	4.5	5.23
Bell 206L4	5	85.2*	14.6	315	80.0* <sup>H</sup>	5.2	4.52
AeroStar 350BA	6	86.8*	21.1	315	80.0* <sup>H</sup>	6.8	6.82
DHC6 - Vistaliner	19	77.3**	16.0	160	69.0** <sup>F</sup>	8.3	2.38
Cessna T207A	6	77.9	19.9	250	69.0 <sup>F</sup>	8.9	4.33
* EPNL level are used for these helicopters.							
** Certification level is the arithmetic average of the Cessna T182 and the Cessna TR182.							

Figure 3 below shows the certificated sound level minus the proposed "quiet technology" criterion for each aircraft on the x-axis. On the y-axis is the length of time in minutes that the aircraft is audible per passenger seat. The results from the "noise efficiency" based analysis shows that there is reasonably good correlation among aircraft when comparing the certificated sound levels adjusted for passenger seats to the time of audibility per passenger seat. The Cessna T207A is the only aircraft that

does not follow the trend of increasing time audible per passenger seat with increasing certificated sound level.

Figure 4 compares the certificated sound levels to the length of time an aircraft is audible without adjusting for passengers. The x-axis shows the certificated sound level for each aircraft minus the "quiet technology" base criterion. On the y-axis is the length of time in minutes that the aircraft is audible without adjusting for passenger seats. The results from this analysis show less correlation between the audibility of aircraft and the certificated sound levels of the aircraft when the results are not adjusted for the number of passenger seats.

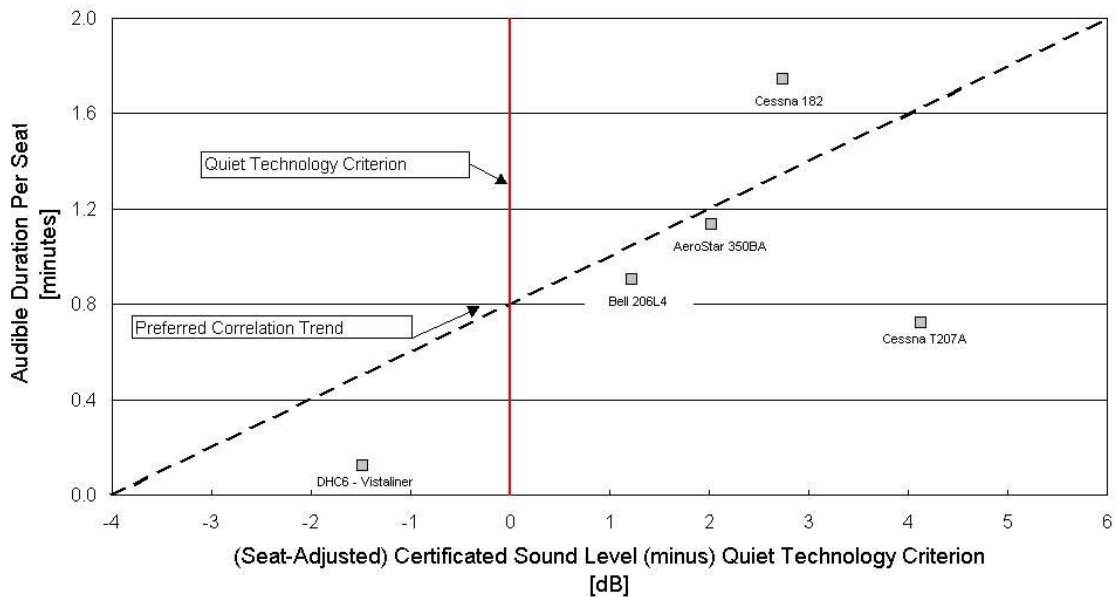


Figure 3. Comparison of Certificated Sound Levels with Time Audible on a "Noise Efficiency" Basis

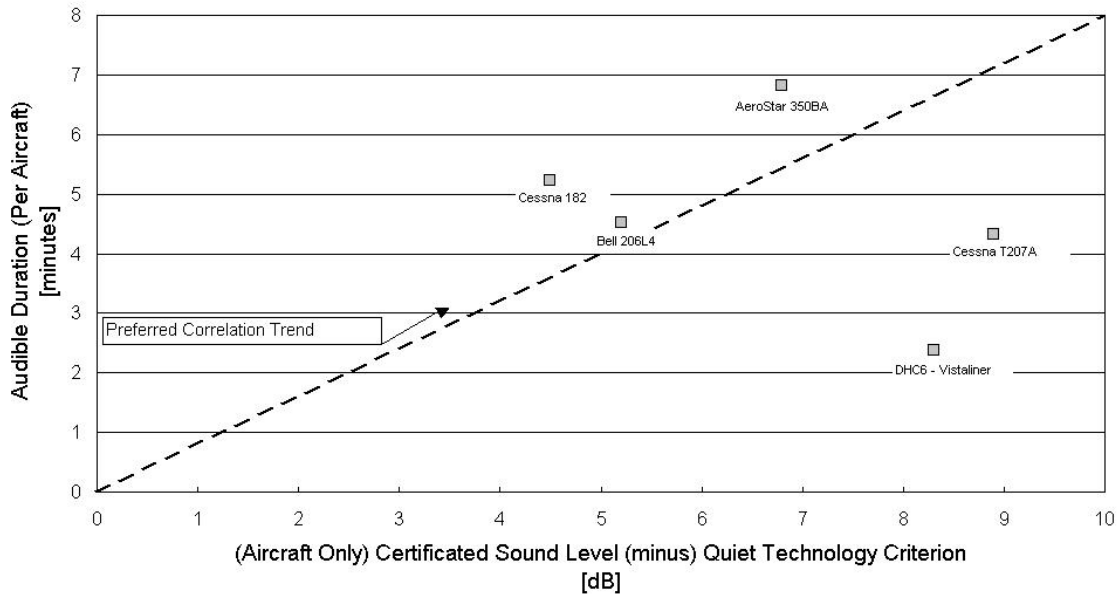


Figure 4. Comparison of Certificated Sound Levels with Time Audible on an "Aircraft-Only" Basis

## 4. Conclusions

This study presents a comparison of FAA's proposed methodology of using certificated noise levels to determine "quiet technology" aircraft in Grand Canyon National Park against predicted audibility based on measured data. Since the NPS has adopted audibility as the primary measure of the "restoration of natural quiet", a metric that is consistent with the actual audibility of air tour flights as they are flown in the Park should be used.

This analysis shows that there is reasonably good correlation between the certification sound levels on a "noise efficiency" basis and the amount of time aircraft are audible per passenger. On an aircraft-to-aircraft basis, however, the correlation between the certification sound levels unadjusted for passenger capacity and the amount of time that aircraft are audible is not as strong. Therefore, the methodology proposed by the FAA on a per seat basis is preferable to that based on an aircraft basis; with either method, there will likely be some aircraft types that have inconsistent results based on a comparison of audibility versus certification data.